



# PIER Energy-Related Environmental Research

Environmental Impacts of Energy Generation, Distribution and Use

## Once Through Cooling Impingement and Entrainment: Identification of Species' Life History Data Gaps

**Contract #:** 500-04-025

**Contractor:** Stratus Consulting

**Contract Amount:** \$235,675

**Contractor Project Manager:** Lara Ferry-Graham

**Subcontractor Project Manager:** Elizabeth Strange

**Commission Project Manager:** Melinda Dorin

### The Issue

A significant portion of California's generation capacity, approximately 45 percent, is derived from facilities located along the state's coast and estuaries that utilize once-through cooling technology. This cooling technology requires the withdrawal of significant amounts of water (~17 billion gallons per day) that is passed by the condenser and then discharged back into a waterbody. Although some of these facilities have been operating since the 1950s, our scientific understanding of the ecological effects of the use of once-through cooling is quite limited. The impacts of cooling water withdrawals are characterized as *entrainment*, where small aquatic organisms are carried by the cooling water into the power plant and killed by heat, and as *impingement*, where the cooling water intake traps larger organisms against the intake screens. Discharge of cooling water heated to levels significantly above temperatures of the receiving waterbody can also alter aquatic ecosystems.



**Black-eyed gobies.**

**Source:** © Joseph Dougherty/ecology.org

Once-through cooled power plants are required to conduct studies to meet the new Clean Water Act 316(b) requirements and existing California Energy Commission licensing requirements. Studies include entrainment sampling and modeling to estimate the numbers of fish being affected and the amount of mitigation required. However, there are knowledge gaps in the methods used to determine and mitigate the impacts.

### Project Description

The project includes the following tasks relating to impingement and entrainment effects attributable to once-through cooling. Through these tasks the researchers seek to identify knowledge gaps, review existing methodologies, and make recommendations. The tasks are:

1. Sensitivity analyses to identify the life history data gaps that are the highest priority for future studies. Life history data are currently unavailable for many impinged and entrained species. It is necessary to identify those data gaps most in need of new data collection, to help minimize the costs and increase the efficiency of data collection efforts and ensure collection of the most relevant data. Existing life history data will be compiled and reviewed by a broad range of California biologists. Extensive sensitivity analyses will then be conducted; these may include species that are most vulnerable to impingement and entrainment, are of high ecological value, or are otherwise considered representative. This task's purpose is to evaluate which life history data gaps are the most critical as inputs to the models most commonly used in 316(b) assessments.
2. Life history modeling to identify indicator species that are monitoring priorities. The U.S. Environmental Protection Agency's section 316(b) regulation for existing facilities recognizes that it may be necessary to focus impingement and entrainment monitoring on a subset of the impinged and entrained species. This task's purpose is to identify which species may be most appropriate in these cases. Researchers will analyze generalized life history types for groups of California estuarine and marine fishes (such as gobies and rockfishes) to determine the following two questions. (1) what is the ability of each modeled life history type to sustain ongoing impingement and entrainment mortality, and (2) which life stages are most important in regulating population dynamics in response to impingement and entrainment? Results will help to identify indicator species and prioritize their monitoring.
3. Identify the critical data gaps and compile the information needed to determine the type, extent, and cost of habitat restoration alternatives for offsetting impingement and entrainment impacts. To determine how much and what type of restoration is needed to offset impingement and entrainment it is necessary to know (1) if habitat is limiting for the species and life stages of interest, (2) what specific habitat is limiting, (3) the annual production of the species and life stages in that habitat, and (4) the costs of alternative restoration actions. This task's purpose is to evaluate these parameters, to facilitate effective habitat restoration. Researchers will assemble data into a database of available habitat information, productivity estimates for impingement and entrainment species, identified data gaps, and restoration costs. The restoration database will be usable by permittees and agencies to determine the cost of realistic and relevant restoration.
4. Conduct a peer review of the Habitat Production Forgone (HPF) model. Many state agencies consider the HPF method to be the best way to express impingement and entrainment losses in an "ecological currency" that is meaningful to a variety of stakeholders and to determine the extent of habitat restoration needed to offset entrainment losses. However, the method and its underlying assumptions have not yet undergone peer review. This task's purpose is to provide that review, including recommendations regarding application of the HPF method and areas where revisions may be needed.
5. Critique the existing analyses of the cumulative impacts of once-through cooling and make recommendations regarding how to conduct such analyses for California's coastal facilities. The cumulative impacts of all of the once-through cooling intakes in California remain largely unknown. Even though many state agencies have expressed interest in determining the type and extent of these cumulative impacts, it remains uncertain what type of analysis is appropriate and possible given available data. This task's purpose is to identify, assemble, and critique existing cumulative impact analyses of impingement and entrainment that have been conducted throughout the country in order to identify those that would be of the most use within California. Results will be used to provide recommendations for steps forward and will help to increase understanding of the key issues involved in designing a cumulative impact analysis for California.

## PIER Program Objectives and Anticipated Benefits for California

This project offers numerous benefits and meets the following PIER program objectives:

- **Improving the environmental and public health costs/risk of California's electricity.** This research will enable the significant number of California power plants using once-through cooling to better address impingement and entrainment issues, which should result in reduced effects to fish populations living near once-through cooling intakes.
- **Conducting research and development activities that will advance science or technology not adequately addressed by the competitive and regulated markets.** This research addresses once-through cooling issues that are not being adequately addressed by other entities.

### Final Report

PIER-EA staff intend to post all the final project reports on the Energy Commission website as the research is completed (fall 2008 for the program final report) and will list the website links here. All reports are also posted at the Water Intake Structure Environmental Research website <http://ecomorphology.mlml.calstate.edu/WISER/>.

### Contact

Melinda Dorin • 916-654-4024 • [mdorin@energy.state.ca.us](mailto:mdorin@energy.state.ca.us)